

# Comparison of WTLN and OKLMA Data

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## Sponsors and Supporters of the OKLMA

⚡ Compared OKLMA and WTLN Data

⚡ Detection

⚡ Flash Classification

⚡ Examined limited data set

⚡ Storm over the OKLMA

⚡ January 20-21, 2010

- ⚡ Identified 116 flashes in the OKLMA VHF data
  - ⚡ Manually determined CG or IC
  - ⚡ Manually examined cognate WTLN data
    - ⚡ Compared automated flash classification with OKLMA
    - ⚡ Examined waveforms and refined classifications

- ⚡ 116 flashes under consideration
  - ⚡ criterion of at least one WTLN fix during the duration of the flash as determined by the LMA
  - ⚡ 109 flashes (94%) detected by WTLN
  - ⚡ Of 109 coincident flashes, 7 not classified as to IC or CG on basis of OKLMA data
  
- ⚡ Of 30 flashes classified as CG on the basis of LMA data, 27 (90%) were classified as CG by the automated WTLN algorithm.
- ⚡
- ⚡ Of 72 flashes classified as IC on the basis of LMA data, 61 (85%) were located by the WTLN and had IC elements.
  - ⚡ Of 61, 28 also had one or more WTLN locations classified as CG within the duration of the IC flash.
    - ⚡ Not too surprising in view of OKLMA characteristics
  
- ⚡ Of 102 flashes classified IC or CG on the basis of OKLMA data, the WTLN detected 88 (86%).

## ⚡ Procedure

- ⚡ Started with beginning time, lat and lon, and duration of the 116 flashes from OKLMA data



- ⚡ Used the XLMA flash algorithm and manual inspection to classify 116 flashes in three categories:

  - ⚡ IC (no indication that VHF source locations approached ground during the flash)

  - ⚡ CG (some indication that VHF source locations approached ground)

  - ⚡ Indeterminate

- ⚡ Compared locations and flash type assignment for

  - ⚡ flashes located by WTLN but not by OKLMA

  - ⚡ flashes located by OKLMA but not by WTLN

  - ⚡ flashes located by both systems

- ⚡ OKLMA flash data in terms of time, lat, lon and duration of the flashes
- ⚡ 8 stations required for a solution
- ⚡
- ⚡ Time, lat and lon of the first VHF source point of the flash as determined using XLMA flash algorithm
- ⚡ Classification of flashes as CG or IC on basis of visual inspection of the points
  - ⚡ CG if there was a succession of points occurring increasingly close to the ground as time advanced
  - ⚡ this could occur at any time during the succession of VHF source locations, tens or even hundreds of ms after the time of the initial source point location

# Some Details and Comments

- ⚡ WTLN automated system saw 104 of the 116 flashes identified from OKLMA data, i.e., 90%.
- ⚡ Independent manual classification agreed for 99 flashes.
- ⚡ Flash classification on the basis of OKLMA data alone agreed with classification by manual inspection of WTLN waveforms for 64 of the 99 flashes.
- ⚡ The 35 cases in which classification based on OKLMA data disagreed with classification based on WTLN waveforms were approximately evenly split among cases in which
  - ⚡ OKLMA did not suggest CG but WTLN waveform indicated RS
  - ⚡ OKLMA indicated CG when manual inspection of waveforms labeled them cloud pulses or leaders
  - ⚡ OKLMA indication was indeterminate
- ⚡ First category above (OKLMA IC, WTLN CG) is not too difficult to explain. It is easy to believe that it might be difficult to tell from LMA points whether a flash makes contact with the ground, for well known reasons.
- ⚡ Second category above (LMA CG, WTLN IC) could result from a too-restrictive definition of what waveforms of return strokes ought to look like or from “attempted leaders” delineated by OKLMA that did not result in a return stroke.

# Flash Type as Function of Time

⚡ Divided time period into roughly 4 minute windows and counted CG and IC flashes

Period	#CG	#IC	Total # flashes	ratios		total flash rate
				CG/IC	IC/CG	
1	0	10	10	0	$\infty$	2.5/min
2	4	2	6	2	0.5	1.5/min
3	6	1	7	6	0.17	1.75/min
4	6	2	8	3	0.33	2.0/min
5	2	7	9	0.29	3.5	2.25/min
6	2	7	9	0.29	3.5	2.25/min
7	4	8	12	0.5	2	3.0/min
8	3	7	10	0.4	2.3	2.5/min
9	1	13	14	0.07	13	3.5/min
10	1	13	14	0.07	13	3.5/min

⚡ Note in this example that total flash rate increased as IC/CG ratio increased.

# Sample of Comparison Spreadsheet

OKLMA UTC	dur sec	lat lma	lon lma	SW	SH	WB	del T ms	WTLN UTC	sw sh wb wt	
23:37:56.422	0.5585	34.9111	-98.0129	IC	(R)	rsn	-0.1	23:37:56.4220657	ic cg cg ic	(cg at 37,61 ms etc)
								outside box		
							36.7	23:37:56.4589284	*	
							61.2	23:37:56.4834321	*	
							62.6	23:37:56.4848241		
							469.0	23:37:56.8911861	*	
							510.5	23:37:56.9326872	*	
								23:38:52.7725435		
23:38:52.7734	0.4281	34.924	-98.0094	CG	(R)	rsn	4.8	23:38:52.7781602	cg cg cg cg	*
							14.9	23:38:52.7883125		
							27.1	23:38:52.8005355	*	
							28.7	23:38:52.8021246	*	
								outside box		
							90.4	23:38:52.8638238	*	
23:39:31.435	0.4037	34.9451	-97.9726	IC	(+)	cp	0.4	23:39:31.4361319	ic ic ic ic	
							4.0	23:39:31.4396941		
							7.5	23:39:31.4432414		
23:40:26.638	0.4885	34.9162	-97.957	IC	(+)	cp		23:40:26.6401111	ic ic ic ic	
							(-3.6)	23:41:44.1992767		
23:41:44.2029	0.4996	34.9293	-97.9938	CG	(R*)	rsn	-1.1	23:41:44.2018265	cg cg cg ic	
							14.6	23:41:44.2174551		
23:43:06.003	0.5781	34.9437	-97.9907	IC	(R)	rsn	0.6	23:43:06.0036785	ic cg cg ic	(cg at 3, 30 ms)
							2.9	23:43:06.0059546	*	
							29.8	23:43:06.0329143	*	
							198.2	23:43:06.2012532		
							374.3	23:43:06.3773531		
							451.0	23:43:06.4541217		
23:44:16.946	0.4917	34.9925	-97.9763	IC	(R)	rsn	3.3	23:44:16.9500931	ic cg cg cg	*(cg at 3.3,245 ms)
							42.5	23:44:16.9893038		
							108.3	23:44:17.0551461		
							244.9	23:44:17.1917245	*	
							246.0	23:44:17.1928049		
							248.0	23:44:17.1947882		

- ⚡ Comparison of LMA and WTLN classifications was based on WTLN waveform at time nearest the beginning of the OKLMA flash interval
  - ⚡ can be misleading
  - ⚡ CG sometimes ms to hundreds of ms after first point
- ⚡ CG flash in the WTLN data at a later time for many of the cases in which there was not one at the beginning

# Suggestions for Future Comparisons

- ⚡ Determine best estimates of times of CG flashes as indicated by sources approaching the ground in the LMA data
- ⚡ Compare times with WTLN CG and IC flash times
- ⚡ Establish “ground truth”  
video, delta E network

# Conclusion

For **this** study

- WTLN detected approximately 90% of total lightning flashes as determined by OKLMA
- WTLN automated flash categorization was approximately 95% correct